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ABSTRACT

Two experiments were performed on two different populations of preschool children with a mean age of 4.5 years. One group was enrolled in a half-day nursery school program and the other attended a full-day program. A microcomputer and age-appropriate software were placed in each classroom according to the following schedule of treatment weeks: baseline, computer-noninteractive (omitted from the second study), computer-interactive, and computer-interactive/teacher-interactive. Children were observed unobtrusively from a position within the computer station. The following behaviors were recorded at 5-minute intervals: (1) child-to-child behaviors, which included positioning for a turn, assisting one another at the computer, enforcement of rules, and domination of the computer; and (2) child-to-computer behaviors, which included object aggression, defending property, key manipulations, and touching the monitor. After the final week, a questionnaire was administered to the children to ascertain the extent of their knowledge, attitudes, and perceptions about their computer experience. It was concluded that preschool children are capable of working with microcomputers and that they can use the standard keyboard with minimal instruction, change software with minimal instruction, and work together at the computer station with minimal teacher supervision. (Author/RH)

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Microcomputers: A Close Look At What Happens When Preschool Children Interact With Age-appropriate Software

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Abstract

Two experiments were performed on two different populations of preschool children with a mean age of 4.5 years. One group constituted a half-day nursery school program and the other a full-day program. A microcomputer with age-appropriate software was placed in each classroom with the following treatment weeks: baseline, computer-noninteractive (dropped from the second study), computer-interactive, and teacher-interactive. Children were observed by an unobtrusive observer from within the computer-station. The following behaviors were recorded at five minute intervals: child to child; positioning for a turn, assisting one another at the computer, enforcement of rules, and domination of the computer; child to computer; object aggression, defending property, key manipulations, and touching the monitor. After the final weeks a questionnaire was administered to the children to ascertain the extent of their knowledge, attitudes, and perceptions about their computer experience. It can be concluded that preschool children are indeed capable of working with microcomputers. Specifically, they can use the standard keyboard with minimal instruction, learn to change software with minimal instruction, and can learn to work together at the computer-station with minimal teacher supervision.

Microcomputers: A Closer Look At What Happens When Preschool Children Interact With Age-appropriate Software

Preschoolers have been observed to work successfully with microcomputers when age-appropriate hardware and software are available (Borgh & Dickson, 1983; Church & Wright, 1983; Pearlman, 1976; Muller, 1983; Swigger & Campbell, 1981; Watt, 1982). These studies and others have noted that children are highly attracted to the computer (Swigger & Campbell, 1981), learn to share the machine with others (Borgh & Dickson, 1983), collaborate and teach each other more when working micros than other classroom activities (Jewson & Pea, 1982), and prefer to work together more often than not (Watt, 1982). Muller (1983) has noted that with age appropriate software even preschoolers are capable of interacting with a computer and working cooperatively with their peers, without the need of constant supervision by teachers. Borgh & Dickson (1983) as well as Muller (1983) have taken the extra effort to record much of the activity that occurs around the microcomputer. For instance they noted that children differed in their approach to the microcomputer, some needed encouragement to be gentle with the computer while others were almost too shy to touch it. These researchers also observed that children were anxious to work at

the computer, sessions lasted from 10 to 20 minutes, and that when two children were present at the same time a substantial portion of their verbal interaction was spent in turntaking. Furthermore, they found that adult intervention to facilitate turntaking decreased over time, and finally that children spend a great deal of time teaching one another.

The information available from the above studies is valuable and timely. However, investigations of young children's interactions with microcomputers and how such interactions effect development are in their infancy. As a new field of inquiry in child development, the results of these and other such studies are in need of relication to establish external validity. Therefore, this study posed the following research questions: What kind of key-striking behaviors do they exhibit? Can they learn to manipulate the computer without special hardware? Can children learn to correctly identify computer hardware/functions with only unstructured teaching occurring? By unstructured teaching we meant the spontaneous interaction of teacher and children during the final week of each study.

Methods

Subjects. The University Nursery School's (part-day program) four year old class, 7 boys and 4 girls, served as the first

target population with the average age being 4.5 years. The University Child Care Education Center's (full-day program) four year old class, 11 girls and 9 boys, served as the second population. These children had an average age of 4.7 years. The two populations were very similar. Both groups of children were around four and a half years old. Both populations of parents were quite highly educated with nearly all of them having at least a bachelors degree. Most of the fathers had some sort of professional training and a great deal of the mothers had masters degrees. Fifteen percent of the second group's mothers had doctorates.

Design. The method used to answer these questions involves a modified behavioral design. "Time Sampling" observations were recorded from a seat located near the microcomputer. In actuality, data was collected for three separate studies at one time. The overall design was the same for each study with differing methods of observations and variables of interest. All three studies were replicated with two different populations of children. The replications will be referred to as Study-1 and Study-2.

A one hour free-play period was observed for four days each week (skipping Mondays) for four consecutive weeks during Study-1

and three consecutive weeks during Study-2. Children wore numbered vests for easy identification and the observer at the computer-station recorded child behaviors in five minute intervals.

Procedures. The role of the observer at the computer-station was to record two types of behavior: behaviors between children (child/child) and between child and computer (child/computer). Behaviors between children were identified as positioning for a turn at the computer, assisting one another at the computer, enforcement of rules concerning the use of the computer and domination of the computer-station and/or machine. Behaviors between the children and computer were labeled as object aggression (hitting, banging, punching the machine), defending property (trying to keep other children from using the machine), key manipulations, and touching the monitor. A running log of these behaviors and child dialog were kept at five minute intervals during all but the final week of each study. During this week the observer became an active participant in the children's unstructured learning about the computer. After the final week, the children were administered a questionnaire to determine the extent of their personal understanding of the computer and the software utilized. Since Stickybear (SB) software; a quality

graphic, age-appropriate software package was used, the questionnaire pertained to specific questions about SB (his origins and capabilities) as well as directed questions about the parts of the computer and their functions.

The four treatment weeks were as follows:

Week 1: BASELINE OBSERVATION - No computer was present in the room therefore no observations could be made at the computer station. Baseline measures for two other studies took place.

Week 2: COMPUTER PRESENT BUT NONINTERACTIVE - Observation of children's behaviors around the computer were made at five minute intervals. A demonstration disk of SB software was in the disk drive so that the computer functioned much like a TV. It could be turned off and on, there were pictures flashing on the screen at all times but it was not interactive. This week was left out of Study-2 because of confounding effects. Children did not know the machine was non-interactive; therefore, when a truly interactive machine was presented to them they expected it to behave in an arcade manner. Their expectations seemed to include the illusion of instantaneous response no matter what was done to the keyboard. Such

unrealistic expectations served only to frustrate the children and interfere with their discovery of the computer.

Week 3: COMPUTER PRESENT AND INTERACTIVE - Observation of computer-station behaviors continues. The computer is now functioning with age-appropriate software such as Sticky Bear ABC's and Numbers.

Week 4: COMPUTER PRESENT AND INTERACTIVE WITH UNSTRUCTURED TEACHING - The only difference between this week and the previous is the addition of an interactive teacher and two more pieces of SB software (Shapes and Opposites). The computer-station observer interacted with the children when invited and when needed to teach correct computer handling, terminology, and functions.

Results and Discussion

CHILD/CHILD. Most of the behaviors observed under this heading; positioning for turn, assisting another, rule enforcement, and dominating the computer remained fairly stable between weeks for both phases (See Figure 1, and Figure 2). There were, however, a couple of interesting trends observed. For example, in Study-1 the children changed from positioning for a turn in the noninteractive week (14% in Study-1, 6% in Study-2) to assisting one another during

the teacher-interactive week (3% in Study-1, 13% in Study-2). In other words, as positioning for a turn at the computer decreased assisting behaviors increased. Children often made comments like the following when positioning for a turn: "I won't be your friend if you don't let me play," "I'll work with you," or "Let me show you how to do it."

Specifically, the children were observed to assist other children in keyboard manipulations and "booting up" of software. It is also interesting to note that from Study-1 children dominating the computer-station decreased from the non-interactive week (9%) to the teacher-interactive week (4%). It is a little difficult to interpret these results due to the confounding effects of the first non-interactive week. As mentioned before, after a week with the arcade-type computer children seemed frustrated by the lack of instantaneous response to which they had become accustomed. All computer behaviors decreased during this truly interactive week simply because fewer children were in the computer area.

During Study-2, the most notable trend was assisting behaviors. Children's helping and teaching behaviors increased from 3% to 12%. It should be noted that although all child/child behaviors increased during the teacher-interactive week of Study-2, assisting had the most dramatic increase. It is possible that this overall trend

in both studies was due to the presence of an interactive teacher. Interaction with the teacher made the computer area all the more interesting to the children. Evidence for this exists in the observation that more children came to the computer-station during those weeks than any other. These observations should help allay the fears of many teachers who feel threatened by technology. The presence of an interactive teacher seemed to give many children the confidence needed to explore the computer.

One further trend warrants emphasis. During the weeks when no teacher was present, children generated a set of rules for use of the microcomputer. Although, at times the rules were a bit egocentric, they nevertheless emphasized turntaking, sharing, and such. Enforcement of these rules increased from 17% to around 24% in both studies, however, as the weeks progressed the rules being enforced changed. In the first weeks, when no teacher involvement occurred, the children tended to enforce rules about sharing and taking turns. In the final weeks, with an interactive and spontaneous teacher present, enforcement centered on proper use of the computer and software. Children continuously made comments like, "Would you stop fighting, you might break this" or "One person at a time" during the noninteractive weeks. Whereas during the teacher-interactive week comments went like this, "Here's how

you get SB to kiss," "I'll show you how to put the disk in," or "Try this button, that's a diamond shape."

Another important observation made concerns how children worked together at the computer. Barnes and Hill (1983) warned that microcomputers will lead young children to become social isolates. This was not found to be true. In both experiments children seemed to form dyads as they came to the computer. This was clearest in Study-1 where there were only 11 children. Nevertheless, during the final week of Study-2, (22 children), at least two dyads were observed repeatedly using the microcomputer. We think the difference was due to there being twice as many Study-2 children desiring to work at the computer. We, therefore, recommend one computer to 10 children for purpose of facilitating social interaction. Furthermore, there was interpersonal aggression observed in the computer-station during Study-2 which manifested itself in the higher frequencies for domination of computer-station. Again we think a great deal of this was due to the large number of childrem competing to work on one computer.

CHILD/COMPUTER. For most of the behaviors under this heading; object aggression, defending property, key manipulations, and touching the monitor there were no dramatic changes between the weeks in each of the studies. We were pleased that high levels of

key-manipulation and monitor-touching behaviors were maintained throughout both studies. We equated high levels of these behaviors with high interest. As with the child/child behaviors, however, one observed trend warrants mentioning; aggression (see Figure 3, and Figure 4).

The most obvious difference was for object aggression in Study-1. During the noninteractive week object aggression accounted for 9% of the behaviors observed. However, in the teacher-interactive week this had fallen to 1%. These percentages reflect the decrease in frequency from 23 to 3. Upon careful observation, it was concluded that this trend resulted from the presence of an interactive teacher. During the noninteractive weeks no one was present to teach the children how to correctly treat the computer. It was felt that intervention to prevent this behavior would insert bias into the study therefore none was made. It should be noted that Apple IIe's are hardy machines which can take a lot of abuse. When the teacher became interactive she was able to teach correct behavior and thus object aggression nearly disappeared.

Although no drastic changes occurred for the other child/computer behaviors, it is interesting to note how the children interacted with the machine. For example, children in both studies consistently touched the monitor. They frequently: counted objects

that appeared on the screen, kissed SB when he would appear, or knocked on a door that opened and closed in several of the programs. Children were observed to count and touch objects as they drove, flew, or danced across the screen.

Children manipulation of the keyboard was another facinating observation. Children in both studies initially pressed one or two keys to see what would happen. When a change on the screen was perceived to be the result of a child's actions the usual response was to press several keys at a time or what we referred to as a "piano playing" the keyboard. The rationale seemed to be the more keys I punch the more I can make happen. This behavior usually disappeared as children gained expertise.

A further interesting observation was made in reference to keyboard manipulations. It seemed that children who watched the screen while manipulating the keys were able to draw connections between specific keys and the graphics on the screen more rapidly. On the other hand, children who watched the keyboard and only attended to the screen when cued by the auditory signal drew such connections more slowly. Some children never made the connection at all, those who did stayed at the computer longer. During the final week of each study children who had made the connection: deliberately pressed specific keys to manipulate the software and

look at particular graphics, were able to change disks as frequently as 3 programs in a 10 minute period, were able to follow simple directions in the software to choose a program from a three-choice picture menu and could anticipate what would occur on the screen. It should be noted that these children amounted to only two or three in each group and often made positive comments like the following: "I did that because I pushed this," "I did four," "I did five."

QUESTIONNAIRE/parts of the computer. On the questionnaire children were asked to name each part of the computer configuration (keyboard, monitor, disk drives, etc.), tell what it does, and later identify an item pointing to it. Generally, it can be said that most, if not all, of the children did better when they were asked to identify a part of the computer by pointing to it after the interviewer named it. For instance only 50% of the Study-1 children could correctly answer the question "What is this" when the teacher pointed to the letter keys. On the other hand 92% of them correctly identified the letter keys when asked to point to them. This supports the theory that children know more than they can verbalize (Polyanyi, 1976).

Study-2 children correctly answered 10-25% more items than the Study-1 children due to the fact that three Study-2 children had computers at home.

In terms of being able to answer the question, "What is this?" the following was observed in terms of both studies. Children answered pretty much the same when asked to name computer parts such as monitor, space bar, number keys, and letter keys. Children in Study-1 were nearly equally split with around 50% getting each item right and wrong whereas Study-2 children answered more questions correctly. The groups differed on keyboard, contrast knob, reset button, on/off button, and white light on keyboard. Study-2 children answered more correctly on keyboard and white light than did Study-1 children who responded more correctly on contrast knob and reset button.

In terms of what does the item do, children in both groups gave correct answers for monitor, spacebar, reset button, letter keys, and white light on keyboard. Again, the Study-1 children were split 50/50 on their answers while the Study-2 children answered 10-25% more correctly. The results were about the same for identifying computer parts when named. Both groups answered more correctly than not for space bar, contrast knob, letter keys, and white light. Study-2 children answered more correctly on

monitor, keyboard, disk drive, on/off button, number keys, and reset button.

QUESTIONNAIRE/software. Children in both studies were asked six questions concerning SB, his origins and capabilities. The following can be said to be true of both groups:

1. A good number of children knew that the computer was responsible for SB's appearance. Other children gave answers to the question of "from where does SB come" like: from a tree, the north pole, his house, the woods, stickland, stickyworld, or stickywoods.

2. Only a limited number of children were able to give any explanation of how SB got on the screen. Such answers went like this: "By the thing that does in there (they would point to the disk drive)," "Because they have a game that has SB on it and we put it in there (disk drive)," "By the cartridge they put in," and "Computers work like that." Less intuitive answers ranged from "Push a button," to "He climbs in the back."

3. Again, only a limited number of children had any idea of where SB goes when he is not on the screen. These children associated SB more with the computer than a real entity. Such answers went like this: "He's just in one of those little slots (disk drive)," or simply "Inside." The less intuitive answers

were indicative of the preschooler's ability to assimilate things better than accommodate them (in his cave, in his tree, in his car). Several children had the best answer of all, "No where."

4. Most children seemed to realize that if they spoke to SB he would be unable to hear them. However, this was not due to any inability on SB's part but rather to physical barriers like the screen. There were a limited number of children who did realize that SB can't hear because he's not real.

5. All of the children with one or two expectations knew that pushing buttons was the way to make SB perform.

6. A majority of the children preferred SB shapes over the other pieces of software that were available. This may be due to the fact that it had a picture menu from which the children could choose the game they wanted, thus more control.

QUESTIONNAIRE/child attitudes and perceptions about computer.

1. All of the children in both groups knew the machine was called a computer.

2. When asked what you do with a computer the children gave a variety of answers. Answers were as follows: "Play with it," "Type things," "Make a picture and things happen," and "Sometimes you add and sometimes you write words." This last child had a computer at home.

3. Children's responses indicated that what they liked most about the computer was having control over it. One child responded, "You can move your fingers and you can do two things at the same time - you can move the buttons and look at the pictures." During the observations some children were so anxious to have control over the machine they made up a little game with the contrast button. They would turn it and say, "Now its night, now its day."

4. When asked how they should touch the keys, all children answered correctly. They knew, by the end of the teacher-interactive week, that one finger punching was most approriate.

5. Children were then asked if the computer was like a TV. It is important to note that nearly all children knew the difference. Their answers reflect a rich knowledge gained from their recent computer experience. Such responses included the following as evidence of a difference: "Buttons, Disk drive, Stays at school," and "A TV doesn't play computer stuff." Similarities such as "Both have a picture," "Both have a screen," were also noted. One child truly knew the difference as evidenced by this comment, "I like TV but I like the computer more cause you get to press the keys and you make things move and I like to make things move." Again, we see evidence of how the children felt about the control they had when working with the microcomputer.

6. Most children indicated they preferred to work with a teacher at the computer. Reasons given were: "Children might break the computer by themselves," "Because the teacher knows more than me," "A teacher can help you," "It's funner," and "So I won't be lonely."

7. When asked if the computer was for boys or girls, the majority of children answered "both." Answers ranged from a logical "There are boys and girls in the school" to a more empathetic "If just for girls, boys would be sad."

8. In terms of who likes the computer best mommies or daddies, the majority of children answered daddies. Next, they indicated the computer was for both mommies and daddies and finally equal numbers of children felt the computer was either for mommies or kids.

CONCLUSIONS. In summary it can be concluded from the above that preschool children are indeed capable of working with microcomputers Specifically, they can use the standard keyboard with minimal instruction, learn to change software with minimal instruction, and can learn to work together at the computer-station with minimal teacher supervision. Children exhibited a great deal of helping and assisting behaviors as the weeks progressed. In addition object aggression directed at the computer decreased. Children were highly attracted to the computer and came to the station in groups of two,

three, four, and five with dyads predominating. Those who watched the screen while manipulating the keyboard were better able to more quickly draw connections between their own actions and the computers reactions.

Children's knowledge of the computer can be influenced with a minimal amount of instruction. For example, though children did poorly as a whole when asked to name parts of the computer, they were much more successful at pointing to the parts when the interviewer named them. Furthermore, the Study-2 children were more successful in answering a greater variety of questions about the computer.

One child summed it up best. When asked what he liked the most about the computer he said, "The thing i like most about the computer, is it's here."

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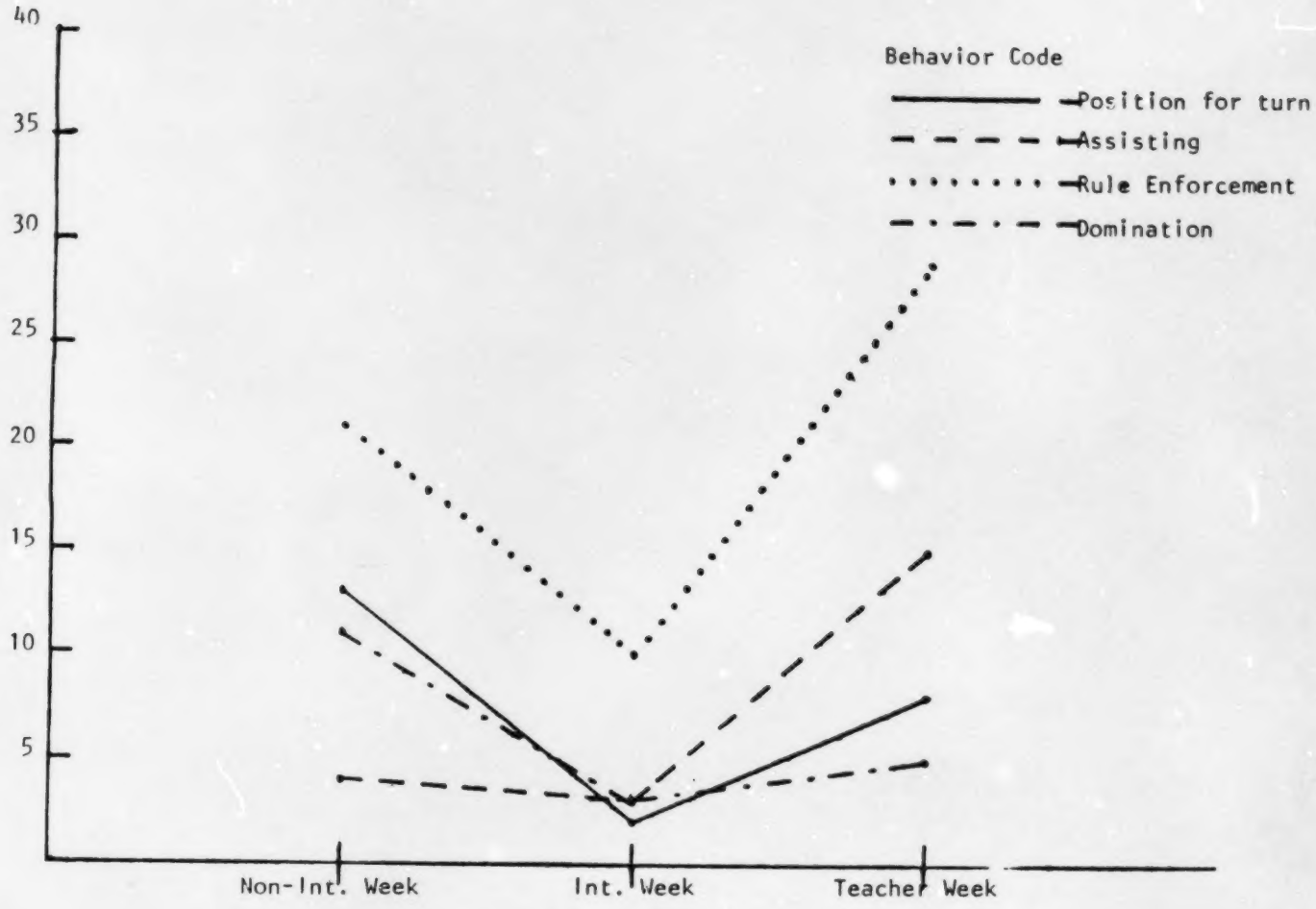

Figure 1. Frequency of Child/Child Behaviors at Computer-station for Study-1.

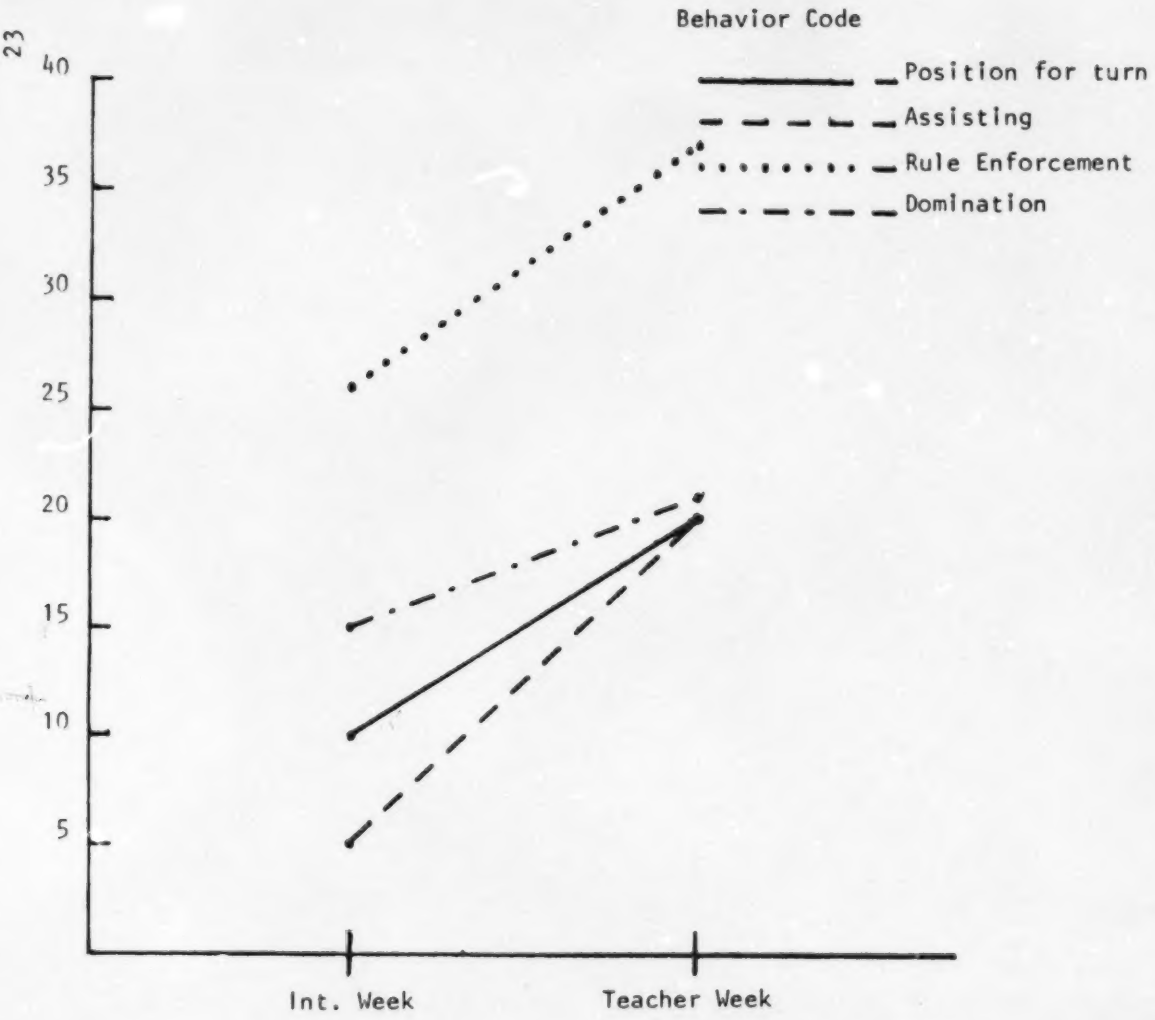

Figure 2. Frequency of Child/Child Behaviors at Computer-station for Study-2.

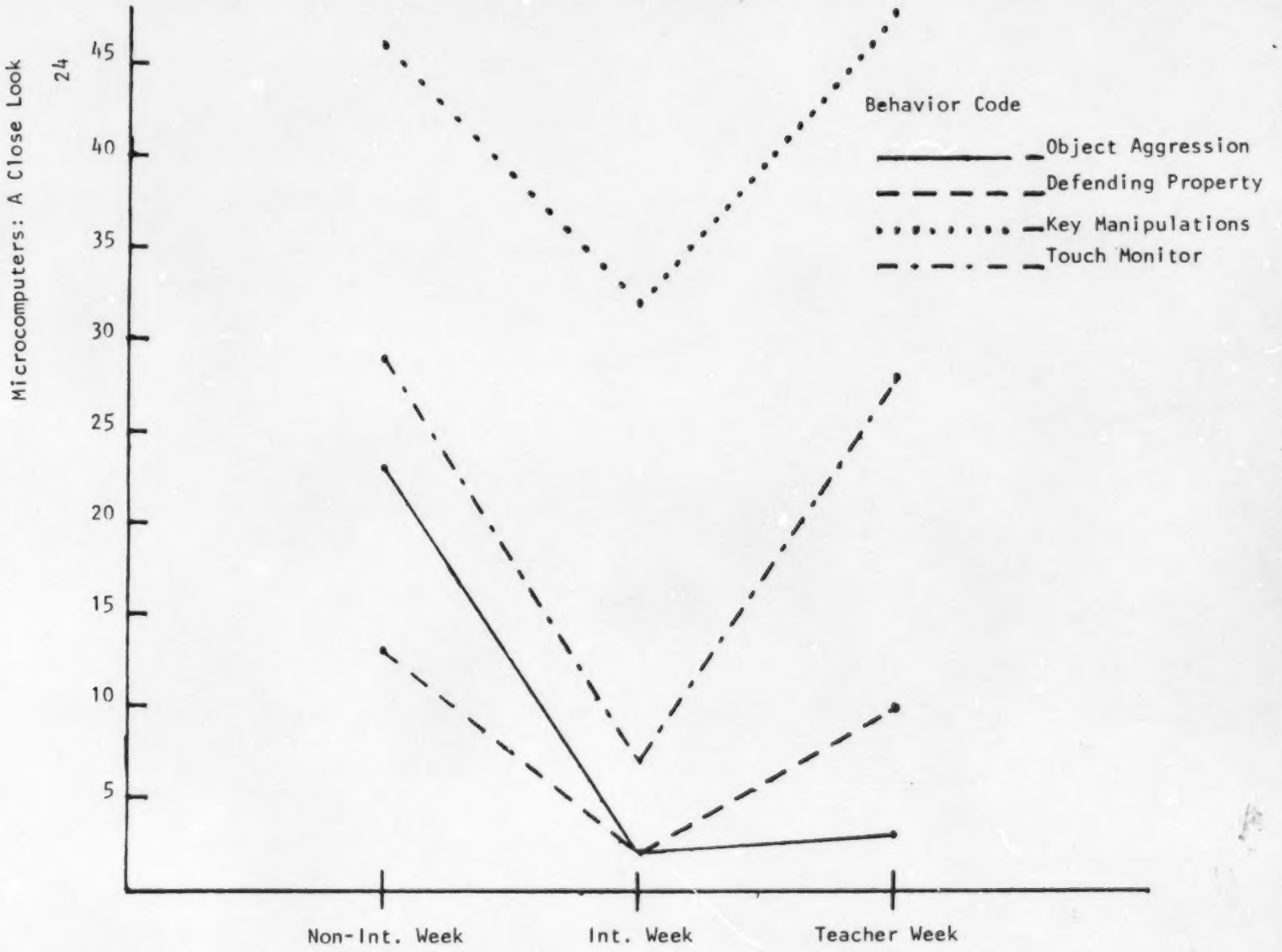

Figure 3. Frequency of Child/Computer Behaviors at Computer-station for Study-1.

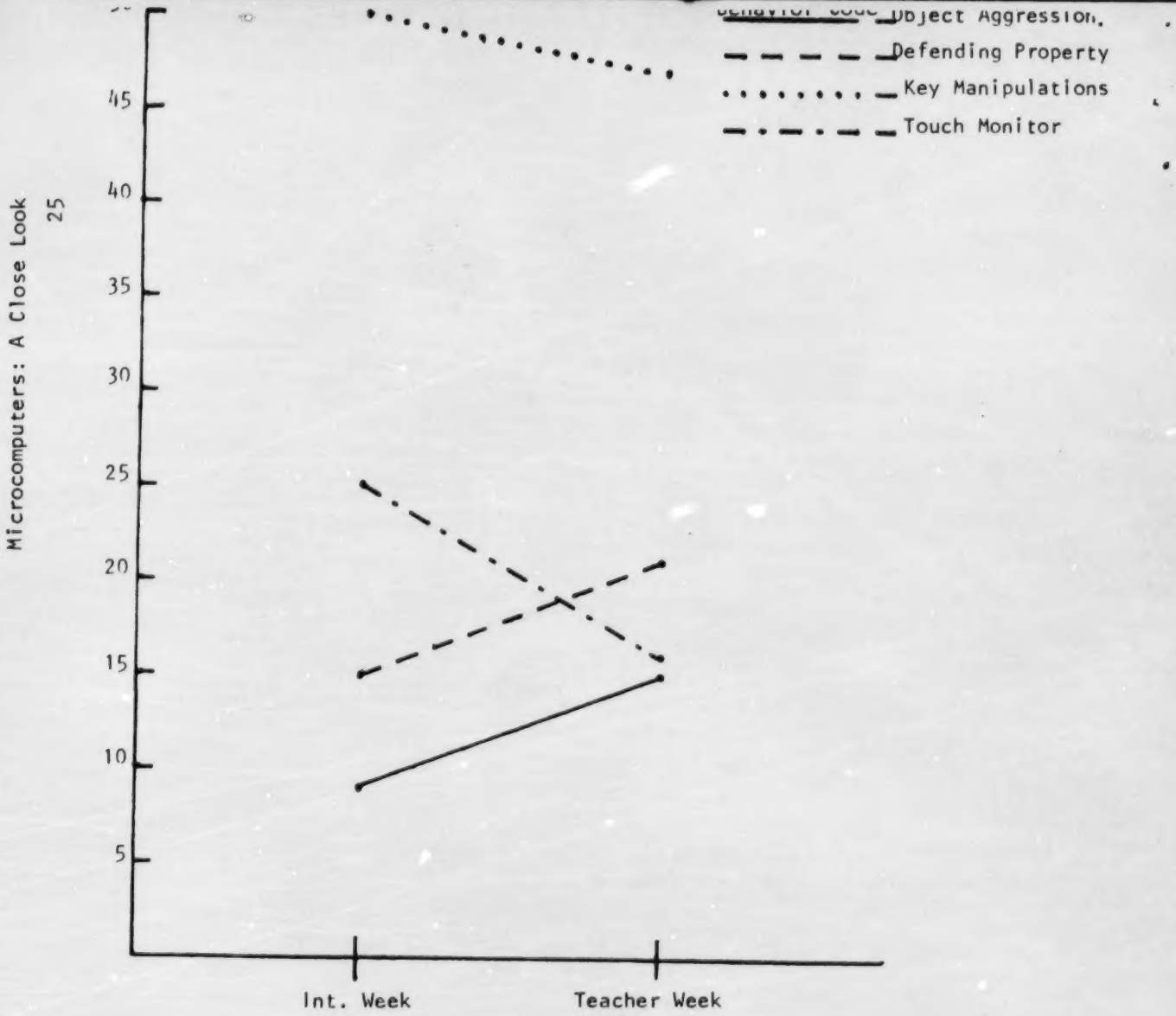

Figure 4. Frequency of Child/Computer Behaviors at Computer-station for Study-2.